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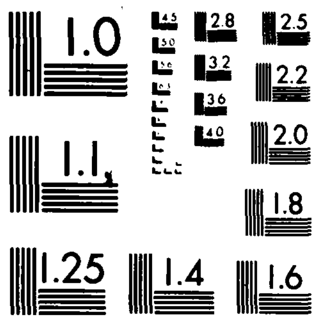

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SATELLITE MEASUREMENTS OF AURORAL COUPLING PROCESSES

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Nov 1982

The high spatial-temporal resolution of instrumentation on the polarorbiting S3-2 satellite has allowed a wide variety of measurements of the electrodynamic characteristics of both large- and small-scale structures at high latitudes. Analyses of large scale features observed by S3-2 have shown that: (i) The IMF B_y dependence of polar cap convection, first observed in June 1969 by OGO-6 persists in other seasons. During periods of northward IMF B_z extensive regions of sunward convection may be found in the sunlit polar cap. (ii) In the dawn and dusk MLT sectors > 90% of the Region 1 currents lie equatorward of the convection reversal line. Potentials across the ionospheric projection of the low-latitude boundary layer are typically a few kV. (iii) The location of "extra" field-aligned currents, near the dayside cusp and poleward of the Region 1 current sheet is dependent on the IMF B_y component. (iv) Simultaneous observations by TRIAD and S3-3 show that sheets of field-aligned current extend uniformly for several hours in MLT, but may have an altitude dependence in the 1000-8000 km range. (v) During magnetic storms ionospheric irregularities generated by scintillations occur in regions of poleward density gradient and downward field aligned current near the equatorward boundary of diffuse auroral precipitation. In the winter polar cap, density irregularities have been found in regions of highly structured electric fields and soft electron precipitation. (vi) During an intense magnetic storm the direction of the electric field component indicated closure of the major field-aligned current pattern by Pederson current flow in the ionosphere. At this active time values of the height-integrated Pederson conductivity in the current-carrying regions were calculated to be in the range 10-30 mho. In the nightside auroral oval current densities calculated from electron fluxes accounted for up to 50% of the upward currents, increasing to better than 70% during the most intense substorm period.

Analysis of small-scale structures (latitudinal width < 1°), observed by S3-2, have shown that: (i) Intense meridional electric fields (50 - 250 mV/m) are generated by charge separation in the magnetosphere at the inner edge of the plasma sheet near the plasmapause. The presence of field-aligned currents, on the order of 1-2 $\mu A/m^2$ indicates an ionospheric conductivity of ~ 1 mho in this region. (ii) Case studies of discrete arcs in the auroral oval have shown that the arc is associated with a pair of small-scale field-aligned currents embedded in the large-scale Region 1/Region 2 field-aligned current sheets. The maximum observed field-aligned current was an upward current of 135 $\mu A/m^2$, confined to a latitudinal width of ~ 2 km. This current was carried by fieldaligned accelerated electrons. Return (downward) currents associated with arcs are limited to intensities of 10-15 μ A/m^2. At this limit the ionospheric plasma becomes marginally stable to the onset of ion-cyclotron turbulence. Two instances of plasma vortices, characteristic of auroral curls, have been observed in the region between the paired current sheets. (iii) Sun-aligned arcs in the polar cap are found in a region of negative electric field divergence, embedded in an irregular electric field pattern. The electrons producing the arcs have temperatures of ~ 200 eV and have been accelerated through potential drops of ~ 1 kV along the magnetic field. Return currents may appear on both sides of these arcs.